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# PATENT ABSTRACTS OF JAPAN

(11)Publication number : **07-110216**  
 (43)Date of publication of application : **25.04.1995**

(51)Int.Cl. **G01B 11/00**

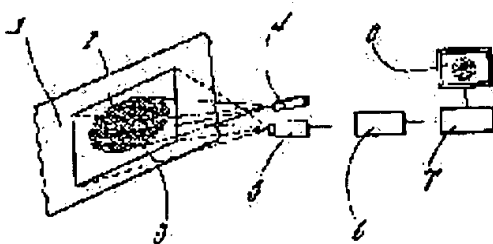
(21)Application number : **05-277437** (71)Applicant : **KISHIMOTO SANGYO KK**  
 (22)Date of filing : **08.10.1993** (72)Inventor : **HIYOSHI TOSHIO**

## (54) METHOD AND INSTRUMENT FOR MEASURING VERTICAL AND LATERAL MOVEMENT OF SPECKLE PATTERN UTILIZING LASER LIGHT

(57)Abstract:

PURPOSE: To recognize a speckle pattern plotted in the wide extent of an area to be irradiated as a mark by irradiating an object to be measured with laser light, to optically detect the mark, and to perform arithmetic processing on the mark and, at the same time, to output and display the processed results as measurements.

CONSTITUTION: A device for measuring the vertical and lateral movement of a speckle pattern is composed of a laser oscillator 4 which makes an object to be measured/plot a speckle pattern 3, CCS camera 5 which recognizes the pattern 3 as a mark, A/D converter 6 which converts analog signals from the camera 5 into digital signals, arithmetic device 7 which calculates the measured values of the digital signals from the converter 6, and CRT 8 which outputs and displays the measurements calculated by the device.



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### DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the method of enabling dynamic measurement by non-contact at a four-directions row, and its equipment, without being comparatively influenced by the aspect of a measured object, i.e., temperature, color, the quality of the material, etc.

[0002]

[Background of the Invention] This invention irradiates a laser beam at a measured object, catches as an indicator the speckle pattern drawn on the image range of an irradiated region, detects this optically, and carries out data processing, makes this measured value further, and indicates by the output.

[0003]

[Description of the Prior Art] The measurement technology by the Doppler effect which the spectrum of the laser beam is carried out [ Doppler effect ] through prism etc. as a method of using a laser beam for the means, and carries out union light of this to a reflective row in the measurement method by non-contact conventionally considers as the general technology in this measurement field, and is known.

[0004]

[Problem(s) to be Solved by the Invention] In said method use a laser beam for the measurement means, and according to the Doppler effect A high precision is required optically, and including much the element with which vibration is especially mentioned as a mechanism-weak point, on the other hand, it is alike, and sets. on the front face of a measured object The indispensable requirements which concentrate a laser beam from a 2-way were provided, it is the technology in which distance-high degree of accuracy is also required by these, and the kind of a measured object, physical properties, the state, etc. had a remarkable limit from these restrictions.

[0005] this invention aims at the development \*\*\*\* expand the restrictions range that plentiful requirements , such as the restrictions by these terms and conditions , cancel in use in the precision side row in composition technology , installation technology , etc. in the conventional technology described technology above , and it should correspond to these , if it be in a measurement method row at the simplification of each means in the equipment , and the kind of a measure object -- it be a thing

[0006]

[Means for Solving the Problem] As a means for this invention making the above-mentioned purpose attain, the method of measuring movement magnitude by non-contact has invention of a method, and it recognizes optically the speckle pattern drawn on the image range of an irradiated region by irradiating a laser beam at a measured object as an indicator, and carries out data processing of this recognition pixel, and comes to carry out the display output of the measurement-size value.

[0007] moreover, the laser-oscillation machine which it is [ machine ] in the equipment which measures the upper and lower sides and horizontal movement magnitude by non-contact as invention of equipment, and makes a speckle pattern draw on a measured object, the CCD camera which catches the aforementioned speckle pattern as an indicator, the A/D converter which changes the analog signal from a CCD camera into a digital signal, the arithmetic unit which computes the measured value of the digital signal from an A/D converter, and the display means which indicates the measurement-size value by the arithmetic unit by the output -- a shell -  
- it is a thing

[0008]

[Function] This invention is divided roughly and has three elements.

[0009] The 1st [ the ] is an element which irradiates a laser beam to a measured object.

[0010] The 2nd [ the ] is an element which speckle-pattern-izes the image range of the irradiated region of a laser beam in a measured object.

[0011] the element which the 3rd [ the ] catches as an indicator the speckle pattern converted into a video signal by the measured object, and this is detected optically, and it carries out data processing, makes this measured value further, and indicates by the output -- it comes out

[0012] If each above-mentioned element is collected and these are summarized synthetically, a laser beam will be irradiated at a measured object. Make a speckle pattern draw on the split-face front face of this measured object, and the light and darkness of the aforementioned speckle

pattern are photoed with a CCD (charge-coupled-device; Charge Coupled Device) (Following CCD is called) camera in parallel with movement of a measured object. Real . time data processing of the electric signal acquired by photography is carried out per CCD pixel by computer, and the display output of the travel numeric value is carried out.

[0013] In order to make the method of this invention attain, it constitutes from semiconductor laser VCO, high resolution CCD, and a A/D (Analog Digital) converter, and it constitutes from CRT (Cathode Ray Tube display) (monitor) in a processing-unit row as the verification machine.

[0014] If a laser beam with very high coherence is irradiated from a laser oscillation machine, in order that the laser beam scattered about by split-face every place of a measured object may interfere each other in a measured object with an uneven front face by the irregular phase relation, a granular pattern arises. This granular pattern is called a SUPERRU pattern.

[0015] Here, when a measured object carries out horizontal movement, there is a property a speckle pattern also carries out [ a property ] horizontal movement in connection with it.

[0016] By using this speckle pattern as an indicator, it photographs continuously by the CCD camera, and an analog signal is changed into a digital signal by the A/D converter, and it considers as the input of an arithmetic unit, and comes to output the pattern to CRT.

[0017]

[Example] Each part grade is explained to the measured object row for attaining the method of this invention as a verification machine below by using the example of this invention as the preceding paragraph explained with drawing.

[0018] 1 is a measured object. 2 is the image range of the CCD (charge-coupled-device; Charge CoupledDevice) camera 5. 3 is a speckle pattern which a laser beam is irradiated by the measured object 1 and the laser oscillation machine 4 draws by the split face. 4 is a laser oscillation machine. 5 is a CCD camera. 6 is a A/D (Analog/Digital) converter which changes the analog signal of CCD camera 5 into a digital signal. 7 is an arithmetic unit which computes the upper and lower sides and horizontal movement magnitude by using a speckle pattern 3 as an indicator. 8 is CRT (Cathode Ray Tube display) which views a speckle pattern 3 directly.

[0019] In order to draw the speckle pattern stabilized in the measured object, high brightness, directivity, and the light are used for the laser oscillation machine 4, and it constitutes it from a laser element, a cooling circuit, a drive circuit, and a lens.

[0020] CCD camera 5 is used in order to photograph the speckle pattern drawn on a measured object, it has the function changed into an NTSC signal (analog data), and the interval of a CCD pixel determines the accuracy of measurement of a travel, and a zoom lens may be used in order to expand or reduce to the roughness and fineness which a computer tends to process with the size of a speckle pattern.

[0021] A/D converter 6 has the function to change an analog signal into a digital signal. An NTSC signal is an analog signal. Therefore, since a speckle pattern is stored in a storage element, it is necessary to change into a digital signal. Since a speckle pattern is a group point pattern by light and darkness, it changes a bright point into "1" and binary-ization which sets \*\*\*\* to "0."

[0022] An arithmetic unit 7 stores the move state (speckle pattern) of a measured object in a storage element continuously, and movement of arbitrary light-and-darkness points is calculated at intervals of a CCD pixel (criteria length), and it carries out a display output as numerical information.

[0023] In verification and experiment / examination stage, CRT8 displays a travel on a speckle pattern row on CRT monitor display, and uses it for the purpose of carrying out the visual sense of a pattern and the move state. However, a display output is carried out in a flight model, using a travel as a numeric value with a seven segment drop.

[0024] When the measured object 1 is used as an aluminum board, it is drawing 2 which took a photograph of the speckle pattern which irradiated the laser beam and actually drew it on this aluminum board.

[0025] A laser beam is irradiated at the measured object 1, a speckle pattern 3 is photoed by CCD camera 5, the neutral colors by light and darkness are removed by A/D converter 6, and it changes into two signals, Ming and dark, and inputs into an arithmetic unit 7.

[0026] Here, in order to give explanation of a method easy, the state where light and darkness were allotted for the speckle pattern 3 which an arithmetic unit 7 recognizes for convenience per CCD pixel is shown in drawing 3 .

[0027] Let the pattern with which the measured object 1 was irradiated and the arithmetic unit 7 has recognized the laser beam be drawing 3 .

[0028] From this state, drawing 4 shows the state where the measured object 1 moved to the left by 1 pixel of CCD, and drawing 5 shows the state where the measured object 1 moved below by 1 pixel of CCD.

[0029] Drawing 6 shows the state where the measured object 1 moved below by 1 pixel further.

[0030] As a result, it is shown from drawing 3 that the measured object moved to the left by 2 pixels in drawing 6 at 1 pixel and the lower part.

[0031] In addition, when the interval per 1 pixel of CCD is set to 10 micrometers, it means that 20 micrometers of measured objects 1 had moved to the left in drawing 6 at 10 micrometers and the lower part from drawing 3 , and movement magnitude can be measured by non-contact.

[0032] Moreover, about a long thing, just before the speckle pattern 3 used as the indicator separates from the visual field of CCD camera 5, it has as an indicator a new appreciation of the pattern generated in a new field, and movement magnitude is measured by the recurrence.

[0033]

[Effect of the Invention] Since a laser beam is irradiated directly at a measured object, this invention can simplify optical system, and it is effective also to the vibration and the shock from the outside.

[0034] Furthermore, since a laser beam is the homogeneous light, the feature which dotage does not generate is in the speckle pattern itself, and it can measure the upper and lower sides and horizontal movement magnitude easily also about a distant measured object by adding a telephoto lens to a CCD camera.

[0035] In addition, there is an effect applicable to acceleration, mean velocity, a seismograph, etc. by applying this method.

[0036]

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**CLAIMS**

[Claim(s)]

[Claim 1] The measuring method of the upper and lower sides by the speckle pattern using the laser beam which is in the method of measuring movement magnitude by non-contact, and recognizes optically the speckle pattern drawn on the image range of an irradiated region by irradiating a laser beam at a measured object as an indicator, and carries out data processing of this recognition pixel, is made to carry out the display output of the measurement-size value, and is characterized by the bird clapper, and horizontal movement magnitude.

[Claim 2] The measuring device of the upper and lower sides by the speckle pattern using the laser beam characterized by providing the following, and horizontal movement magnitude. The laser oscillation machine which it is [ machine ] in the equipment which measures the upper and lower sides and horizontal movement magnitude by non-contact, and makes a speckle pattern draw on a measured object. The display means which indicates the measurement-size value by the CCD camera which catches the aforementioned speckle pattern as an indicator, the A/D converter which changes the analog signal from a CCD camera into a digital signal, the arithmetic

unit which computes the measured value of the digital signal from an A/D-conversion means, and the arithmetic unit by the output.

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**DRAWINGS**

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[Drawing 1]

[Drawing 2]

[Drawing 3]

[Drawing 4]

[Drawing 5]

[Drawing 6]

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[Translation done.]

た図

【図6】 さらにCCD1画素分だけ被計測物が下方に移動した図

【0037】

【符号の説明】

【1】 被計測物

【2】 映像範囲

【3】 スペックルパターン

【4】 レーザ発振器

【5】 CCDカメラ

【6】 A/D変換器

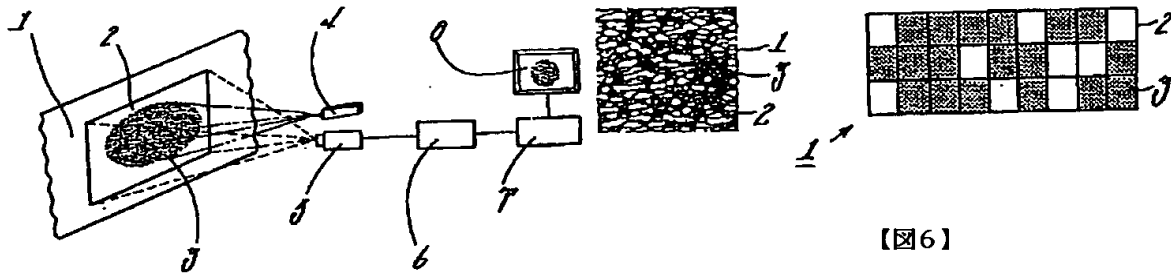
【7】 演算装置

【8】 CRT

【図1】

【図2】

【図3】



【図6】

【図4】

【図5】

